

SECTION 13865

CONTROL SYSTEMS EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Scope

1. Provide labor, materials, and equipment as specified in this section of the specifications and as indicated on DRAWINGS, including accessories as required by manufacturer for fully operational installation.
2. All installation work provided shall be per the recommendations of the equipment manufacturers and as required by the manufacturer's installation instructions and shop drawings.
3. Refer to SECTION 13855 and 13856 for additional control systems equipment requirements.
4. The existing Automated Logic Inc. Building Management System (BMS) shall be extended to control and monitor the new HVAC systems installed as part of this project. The BMS shall also monitor the Refrigerant Monitor System.

B. Verification

1. Study and compare drawings, specifications, methods of construction, and manufacturer's drawings and instructions.
2. Bring discrepancies between manufacturer's instructions and the contract documents to the immediate attention of Owner or his representative for clarification.
 - a. When details or specifications do not agree with the manufacturer's recommendations, advise the Owner or his representative so that corrective action can be taken.

C. Utilization Voltages

1. Furnish controls and powered apparatus suitable for continuous and stable operation from the following power supplies:
 - a. 480 volt, 3 phase, 60 hertz for motor loads.
 - b. 120 volt, 1 phase, 60 hertz for inputs and outputs.
 - c. 120 volt, 1 phase, 60 hertz for lighting, air conditioning, heating and receptacles.
 - d. 120 volt, 1 phase UPS power for PLC controller.
 - e. 4 – 20 mA/24 volts DC for analog inputs and outputs from card.
2. Where equipment requires voltage other than 120 volts, furnish two-winding step-down transformer.
3. If voltages other than those listed are required, provide means for transformation.

D. Design Considerations

1. Design
 - a. Design for single point lockout for greater than 120 volts.
 - b. Auto restart after power outage.

- c. Design control and alarm circuits to fail to safety. That is, open-circuiting of one wire, short-circuiting of wiring or failure of a component shall not cause machinery to start up. Failures shall bring equipment to a safe state.
- d. Select electrical devices on the basis that a 15% voltage dip of 3 seconds or less, or 10% undervoltage indefinitely, does not cause equipment to shut down.
- e. Furnish suitable circuit protection for controls so that one electrical fault does not affect more than one unit or system. Furnish protection by either circuit breaker or fuse with LED terminal.
- f. Furnish a disconnecting means to permit servicing of individual systems or control components.
- g. Furnish contacts such as relays, starters, etc. on 480 volt service for rating of 600 volts minimum; on 120 volt service provide rating for 300 volts minimum.
- h. Furnish non-conductive removable covers over all exposed wire terminations to prevent inadvertent contact with any voltage source greater than 50 volts.
- i. Communications with external systems TCP/IP and OPC.
- j. Communication to remote racks Control Net.

1.2 QUALITY ASSURANCE

- A. Provide per SECTION 13855.

1.3 SUBMITTALS

- A. Provide per SECTION 13855.

B. Submittals

- 1. Typical manufacturer drawings are not acceptable unless revised to show specific equipment being furnished.
- 2. Submit shop drawings showing:
 - a. Equipment outline drawings showing locations of electrical equipment including dimensioned conduit stub-up locations as applicable. Identify components by suitable numbering system of same system used for schematics.
 - b. Certified dimension prints of electrical equipment.
 - c. Base and/or mounting dimensions, including weight of components.
 - d. Schematic diagrams of systems, including power and control equipment supplied.
 - e. Interconnection diagrams showing external connections to equipment furnished and with terminal block properly identified and showing in their true physical relationship within equipment.
 - f. Complete electrical material and equipment list including individual item electrical ratings, manufacturer name and catalogue number.
 - g. Recommended spare parts list; start-up and operation.
 - h. Installation operating and maintenance instruction manuals for electrical equipment as part of equipment manuals.
- 3. Do not start with equipment fabrication before above listed documents have been submitted and formally reviewed and returned by Consultant.
- 4. Submit test plans for approval.

5. After work is complete and testing has been executed:
 - a. Submit final certified drawings.
 - b. Submit test data reports.

PART 2 PRODUCTS

2.1 POWER OPERATED DAMPERS

A. Control Dampers

1. *Multiblade Control Dampers [P]*: Parallel blades for two-position service and opposed blade design for modulating service. Provide interconnecting linkage between two damper assemblies, which are operated by a single damper operator. Face or bypass dampers shall be capable of passing 100% of unit rated cfm with pressure drops approximately the same in either extreme position when pressure drop includes coil and bypass components.
2. Provide blades with nonferrous pivot pins or nonferrous-sleeved pivot pins, and flanged brass sleeve or 1/8 inch wall flanged steel sleeve, with flanged oil-impregnated • olite bushing or graphite impregnated nylon bushing. Provide brass washers between damper blades and • olite bushing flange. Linkages shall be provided with machined nonferrous moving contact surfaces with provisions for oiling. All other linkage connections shall be rigid.
3. Provide blade edges and ends with seals for quiet operation and tight closure. Maximum seal leakage for outside air dampers, shall supply dampers utilized in common header system shall be provided with tight shut-off ability be 1% at 1 inch WG when fully closed. Calk frames into ductwork to prevent bypass leakage.
4. Provide dampers with either a baked enamel finish, a zinc-rich paint finish, or galvanized. Nonferrous surfaces shall not be painted. Frames may be galvanized instead of painted, however, outside air exhaust and return damper frames shall be galvanized after fabrication.
5. When dampers are provided under other SECTIONS or other Contracts, provide damper operators, linkages and all necessary accessories for proper operation. Coordinate damper operator sizes and quantity required with damper configuration being provided.

B. Damper Operators

1. *Damper Operators [P]*: Pneumatic damper operators as indicated on the DRAWINGS.
2. Pneumatic damper actuators shall be piston type with cast aluminum housing, rolling neoprene or molded reinforced elastomeric diaphragm, and adjustable external stops to limit stroke length. Outdoor locations or those locations where temperature falls below minimum operating temperatures shall be provided with equipment to protect actuators.
3. Pneumatic operators shall be capable of providing smooth proportioning control under operating conditions normal to the system. Provide spring return operators for “two-position” control, unless otherwise indicated. Provide reversible operators for modulating control. Provide spring returns on modulating operators where required for fail-safe operation.

4. Equip dampers with operators of sufficient power to control dampers without flutter or hunting through the entire operating range at air velocities at least 20% greater than maximum velocity encountered in design operation. Damper operator rated torque shall be 200% of the torque required to operate the dampers. Furnish operators with sufficient power on close off to provide tight sealing against maximum pressures encountered in system.
5. Provide positioners where two or more operators are controlled from the same controller and where indicated. Positioners shall be mounted directly on the driven device. Feedback from the stem or rod shall be through a pilot spring. Starting point shall be adjustable from 2 to 12 PSI. Operating span shall be adjustable from 5 to 13 PSI.
6. Operators operating in sequence with other operators shall have adjustable operating ranges and setpoints. Operators shall have sufficient power on close off to provide tight sealing against maximum pressures encountered in system. Operators shall cause operated device to fail to position indicated.

2.2 CONTROL VALVES

A. General

1. *Control Valves [B,P]*: Provide control valves as specified and/or indicated on the control valve schedule. Refer to Appendix 13865-A and control valve schedule indicated in Appendix "A".
2. Control valves provided by this CONTRACTOR, but not listed on control valve schedules shall meet the requirements of the commercial grade control valve specification (Appendix 13865-A) and shall be sized by the valve supplier as required for the intended application.
3. Provide intelligent I/P Positioners on modulating valve actuators. Positioner shall use HART interface protocol.

B. Two-Way Solenoid Valves

1. *Two Way Solenoid Valves [B,P]*: Two-way solenoid valves shall be normally closed in-line type, suitable for compressed air service at 135 psig inlet pressure. Valve coil shall be continuous duty for 120 VAC, 60 Hz. Operation. Valve shall be 3/4-inch pipe size and 3/4-inch orifice size. Minimum Cv flow factor = 6. Operating pressure differential shall be 350 psi. Maximum fluid temperature 200 degree F. Coil enclosure shall be NEMA 4X rated.
2. Manufacturer:
 - a. Automatic Switch Co. Cat. No. 8210B26.

2.3 CONTROL PANELS

A. Local Control Panels LCP

1. *Local Control Panels LCP [D]*: Provide a free-standing, NEMA 12, one, two or three door panel(s) of the size and configuration indicated on the DRAWINGS.
2. Panel shall be factory fabricated and assembled and shipped to the project site in one piece for installation.

3. Panel shall be fabricated with 14-gage steel. Panel shall be of welded construction reinforced with struts to facilitate mounting internal equipment. Provide lifting eyes for handling of the panel. All exterior seams shall be continuously welded and ground smooth. Door shall be pan type construction, with oil resistant gasket, with key locking handle, three-point latch, fast operating clamp assembly and common keys. Securely anchor panel to floor. All exterior hardware (screws, hinges, etc.) shall be high-grade steel with polished nickel or chrome plated finish. All interior hardware (screws, nuts, etc.) shall be steel, cadmium plated. Provide latches to hold doors in 90deg position. Roller latches shall be provided to hold door in closed position.
4. Prime coat all steel surfaces with two coats of an approved primer. Finish coat exterior surfaces with two coats of paint, color as selected by OWNER. Finish coat interior surfaces with two coats of white enamel. Finish surfaces shall be smooth and free of all runs, ripples and foreign or abrasion defects to present an unblemished appearance in all respects.
5. Provide perforated or slotted plastic covered wire troughs to route all internal panel wiring. Provide separate wire troughs to route all incoming field cables to the terminal blocks and field cables going directly to panel mounted equipment. Size wire troughs for a maximum of 50% fill.
6. Panel interior lighting shall be by fluorescent strip light fixtures mounted at the top of the panel. Light fixtures shall be wired to a door switch to energize when the door is open. Fixtures shall come complete with guards.
7. Provide 1/8 x 1 inch isolated copper ground bus for the total length of the panel for instrument grounds. Provide separate ground bus for equipment ground to 120 VAC powered field devices and fractional horsepower motors fed from panel.
8. Front panel layout shall, be as indicated on the drawings.
9. Provide one ControlNet ant one 120 VAC convenience outlet with ground fault circuit interrupter for 120VAC single phase service, NEMA 12/43, size 48, 3 Amp breaker, FJ-45 connector for ControlNet. Approved manufacturer shall be Grace Engineering, Model P-B4-M3RF3.
10. Provide 120-volt distribution panel with circuit breakers as required for distribution of 120 VAC throughout the control panel.
11. Provide fully operational control panel.
12. Perform factory acceptance test, witnessed by the Owner and Owner's Engineer to demonstrate complete, fully-functional panel.
13. Installation shall be in accordance with recommendations of the equipment manufacturers and as required by manufacturers' installation instructions and shop drawings.
14. All control cabinets with ten (10) square feet or more of backplate shall be supplied with a folding shelf on the outside of the door that is to be used for support of a programming terminal.
15. Approved Manufacturers as below:
 - a. Hoffman.
 - b. Hammond.
 - c. Rittal.
16. Refer to SECTION 13855 for additional control panel requirements.

B. Wires

1. As specified in Division 16 specifications and as modified and supplemented here.
2. Use Belden 29500 Series VFD cable of the appropriate gage for wiring from MCCs to the variable frequency drives.

C. Communications Cable

1. DH+ and RIO Cable
 - a. The cable shall be 78 ohms, two conductor No. 20 stranded tinned copper, twin axial transmission line cable with tinned copper braid and drain wire. 100% shield coverage similar to a Belden 9463.
 - b. This cable may be identified by the initial "DH+" or "RIO".
2. Ethernet
 - a. Enhanced CAT 6 unshielded twisted pair (4 pairs) with RJ-45 ends (main cabinet only).
 - b. Fiber-optic duplex patch cord with SC ends.
 - c. Fiber-optic cable
 - 1) Fiber count: 6 minimum.
 - 2) Fiber size: 62.5 microns.
 - 3) Fiber type: multimode.
 - 4) Jacket material: PVC.
 - 5) Connectors: SC ends.
3. ControlNet
 - a. The cable shall be RG-6 quad shield cable, similar to Belden 1189A.
 - b. Taps shall be Allen-Bradley.
 - c. Network terminations shall be Allen-Bradley.
 - d. BNC connector shall be Allen-Bradley.

D. Controls Hardware

1. PLCs system based on Allen-Bradley product line
 - a. The main system PLC processors shall be ControlLogix series Revision Level 15 or Owner-approved equivalent. Secondary system PLC processor shall be from the Logix platform, or Owner-approved equivalent to meet the required application.
 - b. The processor system shall have at least one Ethernet port. Additional ports for Data Highway Plus, remote I/O, DeviceNet, ControlNet or others may be required based on project requirements.
 - c. Memory size shall depend on final application program to be installed in the processor. A minimum of 30% spare memory shall be available after final application program installation and system startup.
 - d. The Owner must approve all processors.
2. PLC input/output modules
 - a. Discrete input modules shall be 16 bits and rated for 120 VAC.
 - b. Discrete output modules shall be 16 bits and fused at 2 amps, 120 VAC.
 - c. Discrete contact output modules shall be 16 bits and fused at 2 amps, 120 VAC.
 - d. Analog input modules shall be 4-20 mA.
 - e. Analog output modules shall be 4-20 mA.
 - f. Specialty modules may be used when required (RTD, T/C, etc.).

- g. I/O modules shall be provided in accordance with PLC manufacturer.
 - h. Provide the necessary I/O housing in accordance with series of I/O used with power supply to support housing.
 - 1) Provide sufficient I/O housing to support all inputs and outputs, including 20% spare installed capacity and 20% spare slot capacity.
 - i. Third party I/O modules for special applications shall be used only when the specified I/O modules are not applicable to the design and only with prior written approval from the Owner.
- E. Local LMIs Based on Allen-Bradley Product Line
- 1. Color PanelView Plus 1000 minimum.
 - 2. Communication: Ethernet or ControlNet.
 - 3. The Owner must approve LMI.
- F. Ethernet System
- 1. Ethernet Switch
 - a. High performance unmanaged fast Ethernet switch for harsh industrial environments.
 - b. 100 Mbit/1 Gbit Base T autosensor, 25% spare parts.
 - c. Enhanced image software.
 - d. External 24 VDC.
 - 1) N-Tron.
 - e. Power Supply
 - 1) 24 VDC DIN rail-mountable power supply.
 - 2) Input voltage: 100-120/220-240V, 47-63 Hz.
 - a) Acopian
- G. Execution – General
- 1. Provide as required by equipment manufacturer for proper component operation.
 - 2. Install enclosures so each door can open 120 degrees minimum.
 - 3. Design control panel to keep internal temperature rise below component vendor specifications. Provide enclosure cooling if necessary and compensate for moisture and dirty air environments.
 - 4. Segregate AC control wiring and DC analog wiring with dedicated wiring ducts and terminal strips. White wiring for AC, grey wiring duct for DC and blue wiring duct for intrinsic safety wiring.
 - 5. Segregate internal and external (field) wiring by arranging the wiring duct accordingly.
 - 6. Wiring duct shall be sized so that it will be no more than 50% full by NEC allowance.
 - 7. Arrange terminal wiring in the following column order: vertical, top to bottom, left to right; control power circuit breaker, fuses, and distribution; I/O card 1; I/O card 2; etc. This generally follows ascending wire numbers.
 - 8. All 120 VAC and discrete 24 VDC wiring within control panels shall be #16 AWG type THHN minimum. Wire size must be sufficient for maximum current in the circuit. Shielded signal wire shall be minimum #18 AWG twisted shielded cable. Communication cables shall meet manufacturer's recommendation. Wires for discrete I/O points between I/O card terminals and terminals in the control panel may be #18 AWG Type MTW or

manufacturer I/O module-ready cables. Power wires to and from I/O cards shall be #14 AWG Type THHN.

9. 120 VAC control wiring shall be red. 120 VAC control wiring within a control panel, deriving its power from an outside source shall be yellow and DC power wiring shall be blue.

2.4 FLOW DEVICES

A. Flow Meters

1. *Flow Meters [P]*: Refer to specification Appendix 13865-B for flow meter schedule and specifications.

B. Flow Switches – Thermal Dispersion Type

1. *Flow Switches – Thermal Dispersion Type [P]*: Provide flow switches where shown on the P & ID Drawings.
2. Flow switches shall have a setpoint range that shall extend below the minimum rated flow of the associated pump.
3. Flow switches shall be thermal dispersion type, 120 VAC power input, 2 Amp, single-pole-double-throw output contact with Hastelloy C wetted parts rated for 150 psig.
4. Manufacturer for flow switches in pipe sizes 2" and larger:
 - a. Fluid Components, Inc. Model 12-64.
5. Manufacturer for flow switches in pipe sizes smaller than 2":
 - a. Fluid Components, Inc. Model FS2000L

2.5 LEVEL DEVICES

A. Level Switch Assemblies – Electrode Type

1. *Level Switch Assemblies – Electrode Type [P]*: Floatless electrode type with 316 stainless steel wire-suspended probes and electrode holder, flanged or pressure tight as required. Provide solid-state electrode actuated level relays of type and contact arrangement indicated. (Stilling well provided under the 15000 SERIES Sections of the specification.) (Provide stilling well where required to prevent wave action.)
2. Manufacturer:
 - a. B/W Controls Div. of McGraw-Edison Co. Series 1500 induction relays.
 - b. Magnesonic

B. Liquid Level Transmitters

1. *Liquid Level Transmitter [P]* Level Transmitter:
 - a. Provide a packaged, FM approved, level gauge assembly complete with all auxiliary devices which meets all of the service conditions, measurement parameters and calibration requirements as indicated. The level gauge assembly shall be fully compatible with the process fluid and ambient conditions encountered. Provide a complete specification sheet for each level gauge.
 - b. Level gauge assembly shall consist of a gold plated nichrome wire helix and stainless steel base strip resistance tape sensor, housed in a polypropylene envelope, compact

polypropylene and neoprene filter assembly, PVC sensor housing, and a compact two wire 4-20 mA current transmitter.

- c. Probe length shall be adequate to sense the full depth of the tank or sump per the CONTRACT DRAWINGS. The sensing housing shall mount to a 1-1/2" MNPT mounting connection fitting.
- d. Provide a 1-1/2" PVC stilling tube, with two 1" vent holes located at the top, for field installation.
- e. Manufacture:
 - 1) JOWA Consilium, Aquatape.
 - 2) Other approved.

2.6 PRESSURE DEVICES

A. Pressure Switches

1. *Pressure Switches [P]*: Local surface or pipe mounted switch to provide a contact closure on a pressure increase. Element shall be suitable for the service. Setpoint shall be adjustable over the full range of the instrument with adjustable on/off differential. Electrical switch rating shall be 10 amps at 100 volts AC.
2. Manufacturer:
 - a. Barksdale.
 - b. Dwyer.
 - c. United Electric.
 - d. Ashcroft

B. Differential Pressure Switches

1. *Differential Pressure Switches [P]*: Unit to provide a contact closure on a pressure differential increase between two points. Element shall be suitable for the service. Setpoint shall be adjustable over the full range of the instrument. Electrical switch rating shall be 10 amps at 100 volts AC.
2. Manufacturer:
 - a. Barksdale.
 - b. Dwyer.
 - c. United Electric.

C. Pressure/Differential Pressure Transmitters

1. *Pressure and Differential Pressure Transmitters [P]*: Pressure and differential pressure transmitters shall be 2-wire DC type having a 4 to 20 mADC output. Differential pressure transmitter ranges shall be field adjustable with a 5 to 1 turndown ratio between maximum and minimum spans. Units shall have adjustable output dampening. Complete with local indicator and hardware for pipe stand or surface mounting.
2. Accuracy: Differential Pressure Type – 0.2% of calibrated span. Pressure Type – 0.25% of calibrated span.
3. Standard Unit – Materials of construction for wetted parts: Cadmium plated carbon steel and 315 SST diaphragms.
4. Provide transmitter with HART interface module.

5. Manufacturer:
 - a. Rosemount, Pressure Model 3051GP, Differential Pressure Model 3051 DP.

2.7 TEMPERATURE DEVICES

A. Temperature Transmitters

1. *Temperature Transmitters [P]*: Transmitter shall accept a signal from integral or remote 3-wire 100-ohm platinum resistance type sensor. Output shall be 4-20 mADC 2-wire type with output signal linear with temperature. Loss of input shall force output high (upscale burnout). Accuracy shall be 0.2% of calibrated span. Complete with local indicator and hardware for pipe stand or surface mounting.
2. Platinum resistance sensors shall be 3-wire 100-ohm type with 316 stainless steel sheath and 1/2-inch male pipe thread connector for thermowell mounting. Length to be as required per application. Remote mounted types to have gasketed screw on metal cover type head with field wiring terminals permanently mounted inside the head and provisions for connecting 1/2-inch conduit to the sensor head. For cooling water sump service, sheath shall extend sensor to 3-inches below pump cut-off level.
3. Provide transmitter with HART interface module.
4. Manufacturer:
 - a. Rosemount, Model 644.

2.8 MISCELLANEOUS PANEL DEVICES

A. Power Supplies

1. *Power Supplies [P]*: The output voltages and current capacity shall be as required by the control system with 20% spare capacity. A 24 VDC supply shall be provided for all field transmitters and transducers with 20% spare capacity.
2. Power Supplies shall be of the high efficiency switched type for operation from 120 VAC +/- 10% input. Supply each unit with voltmeter, fuse, over voltage protection and a common NC failure alarm contact output. Provide local indication of output failure for each separate voltage output. For multiple output supplies the voltmeter shall have an output selector switch.
3. Manufacturer:
 - a. Acopian Corp.

B. AC Current Transmitters

1. *AC Current Transmitters [P]*: AC current transmitter shall be a self contained unit with integral doughnut transformer, 4-20 mADC 2-wire output signal, 24 VDC powered. Operating temperature range shall be 0 to 158 deg. F., response time 150 milliseconds maximum. Accuracy 0.5% full scale, repeatability 0.25% full scale. AC current ranges: 1 to 600 AMPS full scale, provide suitable range to match each application.
2. Manufacturer:
 - a. C.S. Technologies Inc. 420 Series.
 - b. Simpson – GIMA Series.

C. Push Buttons

1. *Push buttons [P]*: Momentary contact push button units, non-illuminated. Push buttons shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight.
2. Two position push-pull/twist release units, non-illuminated. Push-pull unit shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight.
3. Manufacturer:
 - a. Allen-Bradley – Bulletin 800T Series.
 - b. Square D – Class 9001 – Type K.

D. Selector Switches

1. *Selector Switches [P]*: Two-position, maintained contact, selector switch units, non-illuminated. Selector switches shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight.
2. Three-position, spring return to center, selector switch units, non-illuminated. Selector switches shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight.
3. Three-position, maintained contact, selector switch units, non-illuminated. Selector switches shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight.
4. Four-position, maintained contact, selector switch units, non-illuminated. Selector switches shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight.
5. Manufacturer:
 - a. Allen-Bradley – Bulletin 800T Series.
 - b. Square D – Class 9001 – Type K.

E. Pilot Lights

1. *Push-To-Test Pilot Light Units [P]*: Pilot lights shall be 30.5 mm, NEMA Type 4/13, watertight and oiltight. Lens colors shall be green, amber, blue, white, or clear as indicated on the DRAWINGS.
2. Manufacturer:
 - a. Allen-Bradley – Bulletin 800T Series.
 - b. Square D – Class 9001 – Type K.

F. Control Relays

1. *Control Relays [P]*: Relays shall be of modular type with convertible contacts. Relay contacts shall have a minimum ten amp continuous rating.
2. Master Control relays shall have contacts rated for 20 Amp continuous carrying current.
3. Furnished surge suppressors (made by relay manufacturer) to be installed across the coil of each DC control relay.
4. Manufacturer:
 - a. Allen-Bradley – Bulletin 700 Type P and PK Direct Drive Cartridge Relays.
 - b. Square D – Class 8501 – Type X and XMO.

G. Alarm Horn – Panel Mounted

1. *Alarm Horn – Panel Mounted [P]*: Horn shall be semi-flush mounted.
2. Horn shall be vibrating type.
3. Voltage: 120 VAC.
4. Manufacturer: Edwards Systems Technology – 884D-N5.

H. Alarm Horn – Speaker Cone and Projector

1. *Alarm Horn – Speaker Cone and Projector [P]*: The alarm horn construction shall be a rugged speaker cone and projector that are constructed of spun aluminum. The die-cast aluminum alarm horn enclosure shall house the internal amplification circuitry, tone module and gain control.
2. Horn shall be solid-state design.
3. Horn shall have built in gain control to allow adjustment of volume from 86dBA to 110dBA at 10 (ten) feet.
4. Alarm tone shall be continuous (steady horn).
5. Voltage: 24VDC.
6. Manufacturer:
 - a. Federal Signal – 350GC and TM6 Steady Horn Module.

I. Rotating Beacon

1. *Rotating Beacon [P]*: The rotating beacon shall feature a parabolic reflector that rotates around a long life lamp, providing 60 flashes per minute in all directions.
2. The housing shall be rated for NEMA Type 3R applications and be constructed to IP41.
3. The lamp shall be rated for 40,000 hours MTBF.
4. Furnish colored dome as indicated on the drawings.
5. Voltage: 120VAC
6. Manufacturer:
 - a. Federal Signal – Vitalite Rotating Warning Light – Model 121S.

J. Signal Conditioner/Isolator

1. *Signal Conditioner/Isolator [P]*: Provide process grade instruments for isolation of field mounted transmitters to panel mounted controllers and indicators. Instrument linearity to be better than 0.05% of full scale.

2.9 COMMERCIAL/HVAC PRODUCTS

A. Line Voltage Thermostats

1. *Line Voltage Thermostats [P]*: Integral manual On-Off-Auto selector switch type if indicated, maximum differential of 2 deg. F, concealed temperature adjustment cover design as approved. Line voltage thermostats shall be rated for the load, single or two-pole as required. Thermostat covers and finishes shall be manufacturer's standard with finishes as selected by the ARCHITECT-ENGINEER.
2. Provide insulating bases for thermostats located on exterior walls. Thermostat guards in office areas shall be finished metal type. Thermostat guards in shop and maintenance areas shall be industrial duty cast metal or wire guard type. Guards and thermostats shall be mounted on separate bases.

B. Electric Low Limit Thermostats

1. *Electric Low Limit Thermostats [P]*: Duct type, UL listed, range 30 to 60 deg. F. Sensing element shall be a 20-foot long capillary tube responding to the lowest temperature sensed along any 12 inches of bulb length. Switch shall be SPST 120/240

VAC, rated for 10 amps at 120 volts full load. Unit shall be manually reset. Provide on low limit thermostat for each 20 square feet or fraction thereof of coil surface area.

2. Manufacturer:
 - a. Honeywell.
 - b. Johnson Controls.
 - c. Siemens.
 - d. Invensys.

C. Thermometers

1. *Thermometers [P]*: Provide thermometers adjacent to each duct, immersion thermostat, temperature sensor, where indicated on the DRAWINGS. Thermometers shall be of the remote bulb type with a minimum 4-1/2 inch diameter dial. Thermometers shall have aluminum case, brass or stainless steel movement, white face with black scale markings, liquid or mercury filled thermal system and with copper or brass bulb. Units shall have adjustment provisions for calibration without removing pointer. Provide thermowells for immersion service and extension necks for insulated ducts and piping.
2. Capillary shall have bronze braided armor and shall be ambient temperature compensated if required to maintain specified accuracy at all ambient extremes. Case shall be ambient temperature compensated. Accuracy shall be plus or minus 1% or better of scale range. Maximum scale divisions shall be 2 deg. F. Select scale ranges such that all expected temperatures are within the range but that it does not extend beyond the extremes more than 25 degrees.
3. Locate dial such that it can be easily read from floor level or operating platform. Provide sufficient capillary length and necessary bulb supports within air streams.
4. Manufacturer:
 - a. Ashcroft.
 - b. Honeywell.
 - c. Johnson Controls.
 - d. Siemens.
 - e. Invensys.
 - f. Terice.

D. Water Flow Switches

1. *Water Flow Switches [P]*: UL listed, suitable for all service application conditions. Body minimum working pressure rating shall equal or exceed service pressure. Switch electrical rating shall be 230 VAC/3.7 ampere, 115 VAC/7.4 ampere and 125 VAC 115-230 VAC pilot duty. Unit shall have two SPST normally open switches. Actuating flow rate shall be field adjustable for the specified and indicated service. Switch location shall preclude exposure to turbulent or pulsating flow conditions. Flow switch shall not cause pressure drop exceeding 2 PSI at maximum system flow rate.
2. Manufacturer:
 - a. McDonnell-Miller.
 - b. Johnson Controls.

E. Solenoid Valves

1. *Solenoid Valves [P]*: UL Listed, heavy duty, field-mounted valves with brass or bronze body and stainless steel trim for 200-PSI WOG service. Rate solenoid for 120 VAC power supply; valves normally open (NO) or normally closed (NC) per indicated service application. Provide manual override operation.
2. Manufacturer:
 - a. Automatic Switch Co. (ASCO).
 - b. Magnetrol Valve Corp.

F. Electrical Switches And Pilot Lights

1. *Electrical Switches and Pilot Lights [P]*: Manual switches used for control of systems shall be NEMA 4/13 type with push-button or toggle operator and maintained or momentary contacts to provide required function. Pilot lights shall be NEMA 4/13 type with "Push-To-Test" function with integral transformer for 6-volt bulbs.
2. Manufacturer:
 - a. Allen-Bradley.
 - b. Square D.
 - c. General Electric.

G. Limit Switches

1. *Limit Switches [P]*: Oil-tight type with operator as necessary to provide required function.
2. Manufacturer:
 - a. Allen-Bradley.
 - b. General Electric.
 - c. Square D.

H. Electrical System Accessories

1. *Electrical System Accessories [B,P]*: Provide transformers, relays, solenoid valves, switches, pilot lights, and other devices and accessories required to complete indicated system. Refer to 13856 Series SECTIONS.

2.10 DIRECT DIGITAL CONTROLLERS

A. Equipment Manufacturer

1. Automated Logic INC.

B. Communication

1. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.
2. Install new wiring and network devices as required to provide a complete and workable control network. Use existing Ethernet backbone for network segments marked "existing" on project drawings.

3. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
4. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - a. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - b. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 15900 Appendix A. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
 - c. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
 - d. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

C. Controller Software

1. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
2. Scheduling. See Paragraph 2.3.D.4 (View and Adjust Operating Schedules). System shall provide the following schedule options as a minimum:
 - a. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - b. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - c. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
3. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
4. Binary and Analog Alarms. See Paragraph 2.3.F.7 (Alarm Processing).
5. Alarm Reporting. See Paragraph 2.3.F.9 (Alarm Reactions).
6. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
7. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Section 15900 Appendix A (Sequences of Operation).

8. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
9. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
10. Energy Calculations.
11. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
12. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
13. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
14. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
15. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 15900 Appendix A (Sequence of Operations).

D. Controllers

1. General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 15900 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.
2. BACnet.
 - a. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 - b. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 - c. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
 - d. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall

- be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
- e. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
 - f. BACnet Communication.
 - 1) Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - 2) BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - 3) Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - 4) Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - 5) Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - 6) Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.
 3. Communication.
 - a. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
 - b. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 - c. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 - d. Stand-Alone Operation. Each piece of equipment specified in Section 15900 Appendix A shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.
 4. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - b. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
 5. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

6. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.
7. Serviceability.
 - a. Controllers shall have diagnostic LEDs for power, communication, and processor.
 - b. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
 - c. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
8. Memory.
 - a. Controller memory shall support operating system, database, and programming requirements.
 - b. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 - c. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
9. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
10. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

E. Input and Output Interface

1. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
2. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
3. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
4. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
5. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
7. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

8. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
9. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.11 OPERATORS WORKSTATION

- A. Minimum PC requirements for Wonderware client stations:

Item	Specification
Processor	Dual-Intel 3.4 Ghz Xeon
Memory	4 Gb 400MHz DDR2 RAM
Hard Drive	146 GB 2xRAID HD
Bus	800MHz Front side Bus
Network	Embedded Gigabit Server Adapter
Optical Drive	24x IDE DVD-ROM
OS	Windows XP

PART 3 EXECUTION

3.1 CONTROL COMPONENT INSTALLATION

- A. Provide per SECTIONS 13855, and 13856 and as required by equipment manufacturer for proper component operation.

END OF SECTION

Revision History	
Date	Rev. No.
A	0
B	0
C	0
D	0
E	0
F	0
02-19-09	0

AWW/djo [IC, CV, EL, ME]

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